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Areawide Waste Treatment and Water Quality Management Planning. Appendix B-5 The Restoration and Maintenance of High Quality Water

Greater Egypt Regional Planning and Development Commission, Carbondale, IL

Prepared for

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Areawide Waste Treatment and Water Quality Management Planning

PB 297033

The Restoration and Maintenance of High Quality Water

Appendix B-5

Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson Counties, Illinois

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Areawide Waste Treatment and Water Quality Management Planning

The Restoration and Maintenance of High Quality Water

Appendix B-5

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Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson Counties, Illinois

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The Restoration and Maintenance of High Quality Water Report is Appendix B-5 of the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois. The report was prepared under Section 208 of the Water Pollution Control Act, as amended. It addresses potential sources of pollution for public water supplies and recreational waters in the Southern Illinois 208 area. Also discussed are recommended controls for mitigation and prevention of pollution problems associated with these water resources.

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November 1978

Michael P. Mauzy
Acting Director
Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, Illinois 62706

Dear Mr. Mauzy:

The Commission is pleased to transmit Appendix B-5, The Restoration and Maintenance of High Quality Water of the 208 Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois. The plan and this document cover the ten Illinois Counties of Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson.

This technical report is an integral part of the Southern Illinois Water Quality Management Plan that is designated to meet the contract requirements of Federal Grant Number P005225-01 under the U. S. Water Pollution Control Act Amendments of 1972, as administered by the United States Environmental Protection Agency.

We trust this submittal of this report, as well as the others comprising the plan, will provide the basis for certification of the plan and continued designation of this area.

Sincerely,

A. S. Kirkikis

A. S. Kirkikis
Executive Director

ASK:db

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United States Environmental Protection Agency

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INTRODUCTION

This report reflects 208 Area Waste Treatment and Water Quality Management Planning Work Program elements III, A, 3 a. and b. The primary purpose of this report is to define and locate high quality waters existing in the ten-county area. High quality waters will be discussed with regard to water supply use, general use, and aquatic life support and with regard to specification of non-degradation waters. Nonpoint and point source effects on high quality surface waters will be discussed and various approaches to the problem of diminishing or removing these effects suggested.

In defining their joint 208 mission, the Greater Egypt Regional Planning and Development Commission and the Southeastern Illinois Regional Planning and Development Commission agreed to "... further the national objective to restore and maintain the chemical, physical, and biological integrity of the Nation's waters (and), to achieve wherever attainable the national goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provide for recreation in and on the water..."

This suggests a desire to improve the quality of polluted waters in the 208 designated area to the point where all natural plant and animal life can propagate in its normal aquatic and wet habitats (especially shellfish, fish, and a full range of fish-food organisms) and where people can swim without the danger of contacting human disease organisms that have passed through or bypassed sewage treatment processes. It suggests that waters that currently meet and waters that surpass such standards must be protected from encroachments that will degrade their quality. This target defines the levels of water quality that are envisioned in the term "high quality water."

High quality surface waters for human consumption and waters for general use and natural life support can be defined in terms of chemical and biological parameters. The definition requires arbitrary, but educated selection of standards that must be met or surpassed. To return pol-

luted waters to high quality, techniques must be found to adjust the chemical content and the biological life-support potential of these waters until the known parameters are at least not in violation of such standards. The standards themselves should be developed not from a desire to use water courses as a waste transport system, but from a desire to meet all possible human needs and at the same time provide an aquatic life-support potential that approaches as near as technically possible to that of pristine waters in each watershed where this is attainable.

Surface waters in the 208 area of Southern Illinois are found in both streams and impoundments. Streams in the 208 area receive point source effluent from municipal sewage facilities, industrial treatment facilities private systems, feedlots, water treatment plants and mines. Non-point sources of pollution are considered collectively as the most serious threat to water quality in the area. Surface runoff is the major mechanism of translocation of non-point pollution. The nonpoint sources of pollution identified in the 208 area are acid mine waste drainage, runoff from cultivated lands, runoff from pastures, feedlots, and orchards, runoff from construction projects, and seepage from inadequate and/or poorly maintained private sewage disposal systems. These point and non-point sources of pollution have created a situation wherein it is unlikely that anything approaching pristine water quality can be seen in even the regional watersheds least impacted by human activities.

Impoundments in the 208 area are manmade. They have been produced to serve as water supply sources, recreational waters, and as water bodies associated with wildlife preservation areas. In most cases these waters have been guarded against pollution to some extent, but since they are filled by runoff waters that have entered streams, the increasing degradation of stream water quality is also having its effect on water quality in impoundments. Some impoundments are still regarded as sources of high quality waters, but widespread general pollution of running waters and high rates of siltation will result, in time, in the loss of even these impoundents as relatively high quality water sources.

Public Law 92-500 reflects a desire to restore and maintain high quality waters. This means that in every watershed segment where water quality has been degraded through various polluting inputs, there should be an effort made to return that water to its natural quality. These efforts must not be limited to meeting standard criteria, but must push beyond them wherever possible toward a non-degraded quality level. Where high quality water does still exist, efforts should be made to prevent degradation of its quality via activities of man.

Efforts to accomplish these goals must recognize that all surface waters are interconnected. In a sense, all surface water whether seeping from a clogged subsurface septic system field, percolating through a coal mine gob pile, spilling from a sewage treatment plant, flowing in a tree lined stream, or standing in a water supply reservoir is a part of the same sheet of water overlying some expanse of the earth's surface. What happens to it in one place will soon have its effect in another.

Public Water Supplies

There are 43 public impoundments of water in the 208 area that are 10 surface acres or larger in size (Table 1). Nine of these are water supply reservoirs in current use and nineteen are former water supply reservoirs that are unused or on standby. The remaining impoundments include recreational and wildlife habitat impoundments. Some of this group occupy watersheds in forested areas where there is limited human impact on water quality.

About ninety-five percent of the residents of Southern Illinois communities in the 208 area are supplied with water from sources which depend on surface runoff. The water resources drawn on by most area suppliers are water impoundments. Seventy nine percent of the communities in the 208 area are using surface waters drawn from impoundments directly and twenty-one percent from streams and rivers directly or via intake channels.

Three reservoirs of 1,800 or more surface acres serve thirty-four 208 area communities. The reservoirs are Rend Lake (18,900 surface acres), Kinkaid Lake (2,700 surface acres), and Cedar Lake (1,800 surface acres). These are all multi-use impoundments. Six other water supply reservoirs are in use in the 208 area. They range from 22 to 220 surface acres in size.

Rend Lake has a supply capacity of 40 million gallons per day. The Rend Lake Conservancy District currently supplies a total of 52 communities through the Rend Lake Intercity Water System. The 200,000 residents served by the district require up to 15 million gallons of water per day on peak days. Most of the communities and about half of the residents served by the Rend Lake Conservancy District are in the 208 area. Kinkaid Lake has a storage capacity of 79,000 acre feet. It serves 8 communities and about nine percent of the population in the 208 area.

Table 1
PUBLIC IMPOUNDMENTS

Name	Surface Acres
FRANKLIN COUNTY	
Benton Lake	67.60
Buckner City Reservoir	16.50
Christopher Old Reservoir	19.80
Christopher New Reservoir	37.80
Hamilton Lake	34.20
Moses Lake	170.00
Rend Lake (Part in Jefferson County)	8,878.00
Sesser Lake	42.50
West Frankfort Old Reservoir	146.00
West Frankfort New Reservoir	214.00
Ziegler City Reservoir	50.00
TOTAL	9,676.40
GALLATIN COUNTY	
Pounds Hollow	27.60
Omaha City Reservoir	22.00
TOTAL	49.60
HAMILTON COUNTY	
Dolan Lake	71.30
McLeansboro New Reservoir	75.00
TOTAL	146.30
HARDIN COUNTY	
Lake Tecumseh	13.00
JACKSON COUNTY	
Lake Murphysboro	144.00
Kinkaid Lake	2,700.00
Cedar Lake	1,800.00
Carbondale City Lake	58.50
TOTAL	4,702.50
JEFFERSON COUNTY	
Jaycees Lake	91.90
Mt. Vernon City Reservoir	130.00
Rend Lake (Part in Franklin County)	10,022.00
Waltonville Lake	15.50
TOTAL	10,258.40
PERRY COUNTY	
Pyramid State Park	134.70
DuQuoin Reservoir	183.00
Pinckneyville Reservoir	165.00
TOTAL	482.70
POPE COUNTY	
Lake Glendale(U.S.F.S.)	79.00
One Horse Gap Lake (U.S.F.S.)	28.00
TOTAL	107.00

Table 1 (Cont'd)

Name	Surface Acres
SALINE COUNTY	
Glen O. Jones	105.00
Eldorado City Reservoir	97.80
Harrisburg Borrow Pit	18.50
Harrisburg Lake	208.90
Harrisburg North Reservoir	31.10
Harrisburg South Reservoir	36.00
TOTAL	497.30

Name	Surface Acres
WILLIAMSON COUNTY	
Crab Orchard Lake	6,910.00
Devil's Kitchen Lake	810.00
Herrin New Reservoir	46.10
Herrin Old Reservoir	51.30
Johnson City Reservoir	59.20
Little Grassy Lake	1,000.00
Marion Reservoir	220.00
TOTAL	9,096.60

Cedar Lake supplies Carbondale and affiliated water districts such as the South 51 Water District which also supples Makanda and several rural subdivisions. About 17.5% of the population of the 208 area is supplied from this reservoir.

Water supply reservoirs are expected to meet state water quality standards set for public supply and food processing waters at the point of intake to a water treatment facility (Table 2). By this standard, Cedar, Kinkaid, and Rend lakes are regarded as high quality reservoirs at present.

Other water supply reservoirs in current use are Omaha City Reservoir in Gallatin County; Eldorado City Reservoir, Harrisburg Lake, Harrisburg North Reservoir, and Harrisburg South Reservoir in Saline County; and Marion Reservoir in Williamson County.

One community and many rural population concentrations rely on private actions to meet water supply needs. In many cases, families supplying their own needs haul impoundment water to their homes from water district supply outlets in truck-borne tanks.

Current water supply needs are being met in most communities from impoundments whose capacity is not being taxed to any great extent. The trend in the 208 area is for communities now drawing from small reservoirs or from streams or wells to make some kind of arrangement for supply from a large major reservoir such as Rend Lake.

Fourteen communities in the 208 area are currently supplied entirely or in part with water from stream channels. These are listed in Table 3 along with the name of the stream used as a water source.

Water needs in the 208 area are being met in terms of volume available. However, several communities are experiencing problems due to siltation and pollution of surface waters. The largest of these communities is Harrisburg, where in periods of low flow mine waste polluted waters must be flushed from the Saline Middle Fork channel before water can be used from Harrisburg Lake. In heavy rainfall periods smaller reservoirs are filled from the Saline River and water supply needs are met from these reservoirs.

Table 2
WATER QUALITY STANDARDS FOR
PUBLIC WATER SUPPLIES AT THE TREATMENT PLANT INTAKE

Parameters	12-Month Average mg/l
Arsenic	0.1
Barium	1.0
Cadmium	0.01
Chromium	0.05
Color units	15.0
Copper	1.0
Cyamide	0.2
Fluoride	2.0
MBAS (foaming agents)	0.5
Iron	0.3
Lead	0.05
Manganese	0.05
Mercury	0.002
Nitrate N	10.0
Nitrate N	1.0
Odor (threshold number)	3.0
Carbon (chloroform ext. CCEm)	0.7

Parameters	12-Month Average mg/l
Chlorinated Hydrocarbons:	
Aldrin	0.001
Chlorodane	0.003
D D T	0.05
Dieldrin	0.001
Endrin	0.0005
Heptachlor	0.0001
Heptachlor Epoxide	0.0001
Lindane	0.005
Methoxychlor	0.1
Toxaphene	0.005
Organo Phosphates Parathion	0.1
Chlorophenoxy Herbicides 2, 4, D	0.02
2, 4, 5-TP or Silvex	0.01
Selenium	0.01
Silver	0.05
Turbidity	1.0
Zinc	5.0

Table 3
COMMUNITIES IN THE 208 AREA USING RIVERS
OR STREAMS AS A WATER SUPPLY SOURCE

County	Community	Water Supply Source
Franklin	Royalton	Big Muddy River
Gallatin	Omaha	Tributary to Bear Creek
Hamilton	Broughton	Indian Creek
Hardin	Elizabethtown	Ohio River
	Rosiclare	Ohio River
Perry	Pinckneyville	Beaucoup Creek
Pope	Golconda	Ohio River
Saline	Carrier Mills	So. Fk. Saline River
	Eldorado	Wolf Creek
	Harrisburg	Mid. Fk. Saline River
	Muddy	Mid. Fk. Saline RIver
	Raleigh	Wolf Creek
Williamson	Hurst-Bush	Big Muddy River
	Marion	Br. of Crab Orchard Creek

In the case of Harrisburg and in other communities, the need is growing to find sources of water which are less polluted by activities of man in the watershed. A reliable source of water that can be easily rendered potable is a current need in these communities. Continued pollution of flowing waters in the 208 area will make this a need in an increasing number of places if measures are not taken to reverse the processes that lead to pollution of the surface runoff waters, direct pollution of streams, and uncontrolled siltation of reservoirs.

Fishable - Swimmable Waters

Making all of our surface waters "fishable" and "swimmable" again is part of the overall goal of P.L. 92-500. Water of high enough quality to serve as an environment for fish and fish-food organisms tends also to be ideal for human recreational activities. These waters are expected to meet standards set for secondary contact and indigenous aquatic life waters. Swimming, water skiing, floating, and other activities in which people enter the waters of impoundments and streams require waters that do not carry high concentrations of chemical pollutants and organic wastes. The same waters which biologists label "semipolluted" on the basis of their examination of the kinds of organisms present (and not present) may be a source of disease organisms for the swimmer.

Immature crayfish, mayflies, stoneflies, caddisflies, and other similar groups of animals are principal food items for bass, bluegills, crappie, trout, various brook fish and other fish favored by man. Some species of macroinvertebrate animals do tolerate high levels of organic or mine-waste pollution but those used as food items by man's favorite game fish tend to be intolerant of these types of pollution.

In addition to available food organisms, the survival needs of fish include sufficient dissolved oxygen, the proper range of pH (acid-base balance), minimal suspended solids, and no more than minute traces of heavy metals and toxic substances in the water and sediments. These needs would be easily met by most continuous flowing Southern Illinois streams in their natural state. The types of pollution found in 208 area streams and impoundments tend to diminish the availability of these necessities to fish and fish-food organisms. Biological and chemical oxygen demand, acid conditions, heavy silt loads, and above tolerance levels of toxic substances are examples of kinds of pollution found in the 208 area. Each of these threatens an important survival need of fish.

Fishable-swimmable waters, then, are waters in which levels of polluting materials are not high enough to retard the numbers or diversity of food organisms, seriously diminish available dissolved oxygen, raise acidity to where pH values of 5 or less occur, raise alkalinity to where pH values above 9 occur, produce a continuous heavy load of silt or infuse the sediments and water with heavy metals and poisons. Most impoundments and some streams in the 208 area meet these requirements and can be classed as fishable-swimmable waters.

On the basis of chemical and bacterial standards even streams regarded as being of high quality in the ten-county 208 area will show frequent violations of certain parameters. The chemical parameter most often violated by generally high quality flowing waters is total iron. When chemical paremeters are averaged over a period of time from several months to a year these high quality streams show mean levels well below the maximums allowed: Bay Creek, Big Grand Pierre Creek, Big Creek, and Lusk Creek in Pope County; Peters Creek and Three Mile Creek in Hardin County; Indian Creek and Six Mile Creek in Jackson County; and the upper reaches of Eagle Creek in Saline County. These are regarded as examples of high quality flowing waters.

Fishable - swimmable or general use waters can be described in terms of chemical parameters (Table 4), but in a practical sense are defined best when individual characteristics and characteristics of the watershed, watercourse, and aquatic communities are also taken into account. Aquatic communities include shellfish and other macroinvertebrates as well as fish. Aquatic macroinvertebrates are a diverse group of small animals which live at least part of their life cycle in the waters of streams and impoundments. The group includes immature stages of many of the insects as well as crustaceans (such as crayfish), clams and snails, flatworms, annelid worms, bryozoans, sponges, and others.

Many of these animals are major food items in the diet of game fish. In high quality waters, they form diverse communities made up of many different species and having a stable balance of numbers within each species. The presence of a small number of species or of a large population of a single specially adapted species are signs of degraded water quality. If macroinvertebrate species diversity is low the success of fish and the desireability of the water for human use or recreation are questionable.

A study was made of macroinvertebrate mean species diversity at eighteen stations on nine streams in the 208 area.[1] (Mean species diversity is a

Table 4
WATER QUALITY STANDARDS FOR SECONDARY CONTACT AND INDIGENOUS AQUATIC LIFE (GENERAL USE STREAM AND IMPOUNDMENT STANDARDS)

Parameters	Levels not to be exceeded (mg/l)	Parameters	Levels not to be exceeded (mg/l)
Ammonia N	1.5	Lead *	0.1
Arsenic *	1.0	Manganese *	1.0
Barium *	5.0	Mercury *	0.0005
Boron *	1.0	Nickel *	1.0
Cadmium *	0.05	Phenols	0.1
Chloride	500.0	Selenium *	1.0
Chromium (hexavalent) *	0.05	Silver *	0.005
		Sulfate	500.0
Chromium (trivalent) *	1.0	Total Dissolved Solids	1000.0
Copper *	0.02	Zinc	1.0
Cyanide	0.025	pH (range)	6.0 - 9.0
Fluoride	1.4	Dissolved Oxygen (minimum)	4.0
Iron *	1.0		

* = Total of parameter

mathematical index expressing a relationship between the number of different species present and the relative numbers of individuals of each species found in a specific habitat or community.) Mean species diversity indices were used as an indicator of water quality and life-supportability at the eighteen stations. The study revealed that the life support-ability of some area streams is seriously threatened by pollution from acid mine-waste drainage. A mean species diversity of less than 3 was considered indicative of disturbance of the stream ecosystem and a mean species diversity of less than 2 indicative of serious degradation of the ecosystem.

At five stations that were unaffected by mine-waste drainage, mean species diversity averaged 4.05 while at thirteen mine-waste affected stations mean species diversity averaged 2.58. At the worst of these stations, only one species could be found and mean species diversity was 0. The station in this study that was least affected by man's activities yielded a mean species diversity of 4.67 with 36 macroinvertebrate species present.

POTENTIAL SOURCES OF POLLUTION

Activities in the 208 area which contribute most directly to the degradation of water quality in streams and impoundments are coal mining, row crop agriculture, orchards, public and private sewage disposal, and hydrographic modifications. There are less important contributors with varying degrees of potential for serious pollution of surface waters. These would include petroleum and gas extraction, silviculture, road and other construction projects, animal feedlots, and fluorspar mining.

For purposes of this report, the pollutants contributed from these sources are classified as siltation; nutrients leading to eutrophication; heavy metals, pesticides and herbicides; and acid coal mine wastes.

Siltation

Suspended solids enter the streams of the 208 area due to farming, mining, construction, channel straightening, tree harvesting, and other activities that remove the vegetation cover from land areas. Accumulations of silt reduce the available habitat for fish food organisms. Suspended solids in the water of streams and impoundments reduce the light available to oxygen releasing plants and make it more difficult for fish to prey on food organisms. Large amounts of suspended solids interfere with the oxygen-carbon dioxide exchange process and cause animals to suffocate.

The entry of suspended solids into streams and impoundments is not easily classified and quantified by source. The preponderance of row crop farming in the 208 area suggests that this activity contributes by far the most sediment to surface waters. This is verified by the tendency of suspended solids levels in streams to decrease as the ratio of row crop to grass and forested lands decreases and increase as that ratio increases.

Soil eroded from land does not all reach the flowing waters in the watershed. Soil transported in peripheral reaches of the watershed will

most likely settle before it reaches the main-stem water course. A certain percentage of eroded soil moved in the watershed does reach the main water course. This percentage can be estimated and given as a sediment delivery rate. Such estimates are most accurate on a site-specific basis, however, they can be calculated for entire watersheds to give a general approximation of what levels of silt may be expected to appear in a given stream. Net sediment delivery rates have been calculated for the watersheds of the Big Muddy River basin found within the 10-county 208 area (Table 5). In this 2,375 square mile drainage area there is a calculated sediment loss of 6,693,295 tons/year. Soil loss that can be tolerated by streams in the watershed has been calculated at 2,921,006 tons/year. This means that 3,772,289 tons/year of erosion loss must be eliminated in the Big Muddy basin to prevent sedimentation beyond tolerable levels in the streams of the basin. This represents an average 57 percent decrease of soil erosion in the basin.

Table 5 shows the net sediment yield estimated to be entering each stream in the Big Muddy watershed. This sediment has a direct effect on water quality. The rate required to deliver this much sediment in each stream is given as the "net sediment delivery rate." The estimated rate of delivery for the stream is given as the "tolerable net delivery rate." The difference between these figures shows the degree to which sedimentation is exceeding the delivery potential of the stream.

When a water supply or other reservoir is placed in the watershed, the delivery rate of that segment is diminished greatly. This means that much of the sediment otherwise delivered by the stream plus all of the sediment it was unable to deliver before can be expected to settle in the reservoir. The rate of siltation of area reservoirs is directly proportional to the net sediment delivery rate of the streams that enter it. This sedimentation process can be estimated and expressed as a percentage of reservoir volume loss per year. An estimate of this storage capacity depletion rate is given for a number of 208 area reservoirs in Table 6. The relative impact of sediments on Lake Kinkaid, Cedar Lake, and Rend Lake (the area's principle water supply reservoirs) can be judged from the sedimentation delivery rate percent figures given for the streams tributary to these reservoirs given in Table 5 . The threat to water supply reservoirs and their general water quality is greatest from row crop agricultural lands.

Mining activities, construction of roads, and silviculture all contribute to the silt load of streams along with farming activities. These are usually temporary inputs and not as extensive as row crop farming in the 208 area. Active and new coal strip mines can cause locally heavy siltation, but new reclamation laws require the restora-

Table 5
BIG MUDDY RIVER BASIN SUMMARY OF SOIL LOSSES

Watershed	Drainage Area	Sediment Delivery Rate	Gross Sediment	Net Sed. Yield	Net Sed. Delivery Rate	Tolerable Losses	Tolerable Net Delivery
	Sq. Miles	%	Tons	Tons/Yr	Tons/Ac/Yr	Tons	Rate/Tons
Casey Fork	163	8.0	772945	61836	0.590	215651	0.165
Cedar Creek	68	10.0	135829	13583	0.312	87083	0.200
Central Big Muddy	160	8.0	457804	36624	0.358	167219	0.131
Crab Orchard	290	6.3	775416	48851	0.293	291277	0.188
Galum Creek	163	8.0	463045	37044	0.355	215942	0.166
Gun Creek	49	12.0	102959	12355	0.394	52355	0.200
Hurricane Creek	24	14.0	93783	13130	0.855	21113	0.192
Kinkaid Creek	64	10.0	148807	14881	0.363	34225	0.084
Lake & Pond Creek	101	9.0	312975	28168	0.436	164832	0.230
Little Muddy	285	6.3	810020	51031	0.280	333159	0.146
Lower Beaucoup	102	9.0	265127	23861	0.037	114892	0.015
Lower Big Muddy	117	9.0	292834	26355	0.351	67987	0.008
Middle Fork	239	7.0	761697	53319	0.349	370224	0.170
Upper Beaucoup	309	6.5	663776	43145	0.218	390733	0.129
Upper Big Muddy	241	7.0	636278	44539	0.290	294314	0.134
Totals	2375		6693295	988722		2821006	

From data gathered and prepared by James Gillooly (S.C.S. retired) for GERP&DC.

Table 6
SEDIMENTATION SUMMARY OF 208 AREA RESERVOIRS

Reservoir	Year Storage Began	Watershed Area Acres	Reservoir Area Acres	Reservoir Storage Capacity				Sedimentation Tons Per Acre Per Year	Depletion of Storage % Loss of Original Capacity Per Year
				Year	Capacity Acre-Feet	Year	Capacity Acre-Feet		
West Frankfort	1926	2,581	182.6	1926	1,608.4	1949	1,487.8	4.0	0.33
New West Frankfort	1945	4,878	213.5	1945	2,654.7	1960	2,390.8	2.75	0.66
Valier Cuting Club	1922	1,580	67	1922	369	1957	320	0.79	0.38
Christopher City	1925	592	43.2	1925	412.8	1960	380.2	1.31	0.23
Lake Carbondale	1926	1,920	144	1926	1,386	1948	1,193	7.94	0.63
Little Cedar Lake	1969	2,227	71.6	1969	757.4	1976	655.8	8.5	1.91
Lake Miller	1944	2,976	142.1	1944	1,746.4	1960	1,658	1.57	0.31
Mt. Vernon	1925	1,670.4	100.6	1925	1,201.2	1959	1,084.4	2.38	0.29
Mt. Vernon Res. #2	1937	6,867	244	1937	1,779	1954	1,667	0.71	0.35
Lake DuQuoin	1920	1,408	92.9	1920	844.4	1949	726	4.98	0.48
Eldorado Res.	1940	109,261	7,013	1940	70,543	1963	63,511	3.1	0.43
Crab Orchard Lake	1913	1,140	37	1913	199	1951	178	0.3	0.48
Herrin Res. #1	1926	2,000	56	1926	804	1936	704	7.0	1.3
Herrin Res. #2	1922	2,464	64	1922	471	1957	394	0.88	0.46
Johnston City Res.	1921	4,150	110	1921	705	1951	590	0.72	0.55
Marion Reservoir	1942	9,664	1,000	1942	26,116.2	1951	25,740.6	3.72	0.14
Little Grassy Lake									

Table prepared by Greater Egypt Regional and Planning Development Commission Staff.

tion of mine sites to original contour and revegetation, thus in time little or no more siltation will come from the mined area than from surrounding land with the same land use as that to which the mine was reclaimed. It will take a number of years for this condition to be reached, however, because the soil returned in reclamation is more loosely consolidated than surrounding soil.

An examination of levels of suspended solids found at various 208 sampling stations demonstrated that the presence of previously mined lands in the watershed tends to result in less suspended solids in the streams than is found where row crop agriculture predominates. However, erosion of the steep inclines of end cuts on recently mined land and erosion of soil not yet stabilized by established revegetation projects can cause locally severe short-term erosion problems that surpass normal row crop erosion levels.

Stream channelization and other hydrographic modifications cause increases in the silt load of streams due to the removal of vegetation, loosening of soil, and the increase in velocity of the flowing water. Banks are usually left steep thus bank erosion by heavy rainfall becomes an additional source of silt. Channelization also tends to increase degrading in the headwaters. When the flow slows in original stream bed segments and near the stream mouth, much of the silt load settles causing alteration of the aquatic habitat from sand and rock to deep mud. In addition, channelization usually leads to loss of canopy and shade, with resultant rising water temperatures, drying of surrounding soils, and reduction of wildlife habitat and protection. Fish habitats and spawning areas are lost due to the cut-off of oxbows and side channels and smoothing of stream bottoms. All of these things are evident in the channelized segments of the Saline River drainage.

Silting in of reservoirs causes more than the continuous decrease in storage capacity. The composition of the sediment increasingly reflects chemical constituents of the watershed soils, some of which enter the water in solution. Pesticides, herbicides, and heavy metals, all potentially poisonous to living things, have been shown to accumulate in the sediments of water supply reservoirs in this way. Cedar Lake which supplies water to Carbondale area homes and public places has been shown to contain DDE at one of eight sampling points and dieldrin at three of eight sampling points.[2] These samples were taken during the third year since the reservoir was filled. Crab Orchard Lake has similarly shown accumulations of pesticides and herbicides.[3] The Cedar Lake drainage basin contains row crop land forested areas, and many fruit orchards. Pesticides and herbicides are commonly used on row crop and orchard lands.

Pesticides, Herbicides and Heavy Metals

When heavy metals such as lead, mercury, and cadmium, and toxic substances such as arsenic, DDT, dieldrin, and polychlorinated biphenyls (PCB) enter streams and impoundments from the watershed surface runoff, they are ingested by detritus-eating macroinvertebrates. These organisms are eaten by fish in large numbers. A concentration of the toxic substances occurs in the fish through this biomagnification process. Animals which eat these fish (larger fish, birds, man) may get harmful concentrations of these toxic substances.

Arsenic, lead, copper, zinc, iron, and mercury are all present in the soils, alluvial sediments, lake sediments, and interstitial and interface waters of Cedar Lake. The amounts are all very small at this time and this reservoir is regarded as a high quality body of water because of its low level of nutrients. The appearance of such pollutants in the reservoir underscores the effect of settling sediments from agricultural and orchard acreage on any type of impoundment and provides cause for action in order to retain the reservoir as a body of high quality water.

Fish collected in Cedar Lake in 1976 showed a tissue content of mercury which exceeded tolerance levels as set by the F.D.A. (500 ppb) for human consumption (Table 7). In a Crab Orchard Lake study[4] it was shown that large mouth bass tend to accumulate more mercury than bluegill, bullhead, catfish, or carp. This reflects both their larger weight and their position in the food chain, as consumers of small fish which have already concentrated this heavy metal by eating many macroinvertebrates. The bottom feeders; catfish, bullheads, and carp showed smaller concentrations of mercury than large mouth bass or bluegill. This pattern was also reflected in the Cedar Lake findings except that age group also seemed important (Table 6).

Nutrients

Eroded soil from agricultural lands may introduce fertilizer nutrients into stream and impoundment waters. Potassium, nitrate, and phosphate are commonly found in agricultural fertilizers. When these ions enter streams and impoundments, they increase the nutrient value of the water. Potassium is nearly always plentiful in surface waters, but nitrates and/or phosphates are likely to be in short supply under normal conditions. The ion(s) in short supply become(s) a "limiting factor" serving to keep populations of algae, bacteria, and floating and rooted

Table 7
AVERAGE CONCENTRATIONS OF MERCURY DETECTED
IN FISH TAKEN FROM CEDAR LAKE MAY 19, 1976
IN SIZE GROUPS

Type of Fish	Average Size	Mercury (ppb) Range	Mercury (ppb) Average
Large Mouth Bass			
10-12 inch	11.3	360-555	497
16-19 inch	18.3	1500-1800	1633
Bluegill (all)	6.2	520-880	639
Bullhead			
6- 7 inch	6.5	230-1200	511
12-13 inch	12.7	1160-1650	1405
Carp (all)	16.8	150-220	178

Prepared from information supplied by Illinois State Water Survey.

plants in check. This type of limiting factor helps maintain a balance and diversity of living things in aquatic habitats. Without a limiting factor, unchecked growth of algae, duckweed, bacteria, and other forms would soon create a smelly, choked, unpleasant-looking body of water.

If sewage, agricultural fertilizers, runoff from animal feedlots, or seepage from faulty septic systems enter the water, the limiting factor for the habitat may be supplied in abundance by these pollution sources. Rapid population growth will then occur in the short life cycle organisms causing "blooms." The density of these organisms (usually the bluegreen algae) shortens the distance sunlight will penetrate into the water. The plant life, including other algae no longer receiving enough light, will die and decay. The decay process draws oxygen from the water. This increased biological oxygen demand (B.O.D.) will lower the dissolved oxygen supply and cause the suffication of fish and most fish-food organisms. This die-off of animals further increases the B.O.D. The end result is a much altered habitat unable to support any but specially adapted species. Species that usually occupy the oxygen-poor depths of stratified lakes will next begin to flourish where clean water species would normally live. Decomposing bacteria will also multiply greatly in the sediments. Such a series of events is triggered not by a bloom of algae, but by nutrient enrichment (eutrophication) from outside the body of water.

In their examination of the Cedar Lake reservoir,[5] Illinois State Water Survey found higher values for total phosphorus in the lower strata than near or at the surface. This pointed out the importance of bottom sediments as a source of this probable limiting factor. Generally Cedar Lake was found to be much lower in phosphorus than would be expected of lakes in a state of eutrophication. This helps to establish Cedar Lake as a high quality body of water.

In Rend Lake phosphorus is viewed as the limiting factor for algal growth.[6] Streams entering Rend Lake were found to be in violation of state standards for streams entering impoundments (0.05 mg/l) from 70 to 100 percent of the times tested. Dissolved phosphorus is the most biologically active form. It was found that 25 to 77 percent of the total phosphorus in the six streams tributory to Rend Lake was dissolved phosphorus. Highest phosphorus figures were found for Casey Fork which was in violation for this parameter 100 percent of the time tested and maintained an abnormally high (77 percent) of dissolved phosphorus. The principal source of this polluting input to Rend Lake is thought to be sewage effluent.[7] Rend Lake does not show signs of degradation currently. However, the levels of phosphorus and nitrogen being brought in by tributary streams could in time lead to eutrophication of the lake.[8]

Eutrohpication reactions to nutrients are most pronounced in impounded waters, but obvious, unpleasant changes occur in streams as well, including a change in the aquatic flora and fauna such that desirable species of fish will disappear. Increases in amount of the limiting ion(s) may go unnoticed until relatively high levels occur, then the changes which occur in the biota will become difficult or impossible to reverse for many years.

Copper sulfate is often used in nutrient-enriched impoundments to kill off blooms of algae. A study of Lake DuQuoin in Perry County showed the result of 34 years of such treatment 3 years after the practice had been discontinued.[9] Lake sediments accumulated after the practice began showed copper concentrations of 145, 277, 375, 418, and 276 parts per million (mg/l) while sediments accumulated before showed concentrations at the same stations of 8.5, 51, 33, 18, and 11, respectively. The latter could be said to represent the background conditions for this watershed and the former to represent an accumulated pollution level of this heavy metal ion.

Fertilizers are extensively used on row crop lands in the 208 area. Heaviest applications are made on corn croplands. Unused fertilizer nitrogen eventually reverts to the nitrate ion form. Since the negatively charged nitrate ion is not attracted to clay particles, it easily becomes part of the load carried by runoff waters. Thus over-application can lead to nutrient pollution of water.

At I.E.P.A. stations in the 208 area, nitrogen is monitored as nitrate-nitrite and as ammonia nitrogen. Illinois water quality standards for nitrate-nitrite and ammonia-N in streams are 99.9 mg/l and 1.5 mg/l respectively. There were no violations of the nitrate-nitrite parameter in the 208 area in the years 1972-1975; however, two violations of the ammonia-N parameter occurred in Big Muddy drainage basin sampling sites in 1975, 3 in 1974, 4 in 1973, and 7 in 1972. All of these were in heavily row cropped areas.

Organic nutrients from sewage can create eutrophic conditions in impoundments and streams also. Lake of Egypt, a multi-purpose impoundment in Williamson County, has extensive development of its shoreline for private homes. Sewage from faulty septic systems has entered the lake through seepage to the surface carried downhill to the shallow, quiet bays during rainfall. The pollution at Lake of Egypt had been described as a serious health hazard by public health authorities in 1975 when

1,004 permanent dwelling units were present within the perimeters of the lake shoreline. Forty-five others were then under construction and the possibilities existed that a total of 3,401 dwelling units would be eventually developed.[10] An Illinois State Health Hazard Grant was obtained in 1976 to provide for construction of sewerage and treatment facilities sufficient to handle 136,000 gallons per day. The project is in the design stage.[11] This facility will be sufficient for the current number of dwellings (1,342) but cannot handle sewage from the total possible development around the lake.

In a 1976 study of Crab Orchard Lake in Williamson County,[12] very high coliform bacterial counts were found in 26 of 30 samples taken near the entry point of sewage treatment plant effluent from Carterville. Coliform and fecal coliform standards were set such that if two successive weekly samples at the Crab Orchard Lake bathing beaches exceeded 5000 per 100 ml coliform or 500 per 100 ml fecal coliform the beach would be closed. Thirty-two percent of samples from the main body of the lake were unsatisfactory by this standard and 5.92% of samples taken at 4 bathing beaches were in violation of these standards. In a related biological study, Crab Orchard Creek was considered "semi-polluted" at 5 of the 9 stations upstream of Crab Orchard Lake including the last 4 stations.[13]

The poor water quality of the last four stations was largely due to poor quality effluent from the South East Marion sewage treatment facility.

Other man-caused natural imbalances can contribute to eutrophication-type influences. One example is increased population of deer. No longer held in check by natural predators, large herds squeezed into increasingly small "wild" area increase the impact of wildlife defecation on clear streams such as Lusk Creek.

Coal Mining

Coal mining has produced the most difficult water quality problems in the 208 area. Layers of shale overburden and washings from the coal layer have been left in piles on the surface at old and abandoned mine sites. These refuse residues (gob and slurry) contain varying amounts of metalic pyrites. The most common of these are iron pyrite and marcasite (both FeS). Percolation of water through these materials, when exposed to available oxygen, results in an acidic runoff of rain water

resulting in acidification of streams running through mine refuse areas and possible acid flows from old underground mines. Dissolved pyrites oxidize to ferric sulfate ($Fe\ SO_4$) which can further oxidize in water yielding ferric hydroxide ($Fe(OH)_3$) which precipitates with other metallic compounds as a yellow to reddish-yellow coating on stream substrata (yellow boy). Sulfuric acid (H_2SO_4) is produced in the same reaction lowering the pH value in the affected waters. Coating of the habitat by ferric hydroxide makes population by most small aquatic animals impossible. Fish and other animals will not survive if pH value falls below 5 and remains low for an extended period of time.

Water analysis results from 13 sampling sites downstream from mine-waste drainage areas gave averages in violation of state water quality standards for iron at all of the sites and in violation of standards for sulfates at six of the sites.[14] pH value standards were violated by the average at three of the sites and total dissolved solids averages were in violation at six of the sampling sites. At two sampling sites used in the same study that were upstream from mine-waste drainage areas, the standard for total iron was violated by the average at one of the sampling sites, but no other standard was violated. The following are overall averages for two mine waste related parameters and mean species diversity for sampling sites up and downstream from mine-waste drainage areas used in the study:

	Iron (mg/l)	Sulfate (mg/l)	MSD
Sites upstream from mining -	0.8	101	4.23
Sites downstream from mining -	9.1	685	2.59
Water quality standard -	1.0	500	

Some streams not included in the averages given above have badly acid mine-waste polluted segments. The South Fork of the Saline River is one such stream. At one station on this stream, downstream from both active and inactive coal mining, pH ranged from 2.4 to 5.5 (the standard is 6-9); sulfate from 30 to 2400 mg/l; total dissolved solids from 390 to 3620 mg/l (more than 3 times the standard); and acidity from 4 to 700 mg/l.

At some places, the water is blackened with transported coal fines and ferric hydroxide permeates the sand bottom and coats rocks, logs, etc. These stream segments support no in-stream life. A small number of adapted species live in mine waste polluted waters, but when acidity rises above 30 mg/l with pH values reaching averages well below 5.0, all

stream life may be eliminated. Such water is unfit for livestock to drink and cannot be made potable by normal treatment procedures.

Acid mine-waste pollution is affecting the Harrisburg water supply. Whenever it is necessary to take water from a back-up reservoir via the Saline river channel, it must be flushed of the products of mine waste before the supplementary water can be transferred to the Harrisburg reservoir.

In the Big Muddy watershed portion of the 208 area and in parts of the Saline Basin where limestone bedrock is near enough to the surface, surface mining introduces limestone to the surface waters as well as acid producing pyrites. This creates a buffering effect which tends to keep alkalinity, and thus the pH value, high in spite of the acid producing reactions. Sulfates, total solids, and total iron continue high in reflection of the mine-waste input, but the life supportability of these waters is better than in those areas of the Saline basin where limestone buffering is weak or unavailable.

Major problem areas are where surface mines open to the Davis and DeKoven seams in the southern portions of the Saline basin.[15] Limestone layers here are absent, thin, or weakly calcerious. In addition, a highly pyritic shale lies between the coal seams and must be removed as overburden. The results can be seen in badly polluted segments of Sugar Creek and the South Fork of the Saline River.

A similar problem occurs with the Murphysboro seam in southeastern Jackson County and western Williamson County. Where this seam has been mined, the overburden has proved to be highly pyritic and acid drainage from it highly polluting to surface waters. This has had a very degrading effect on the water quality of Sycamore Creek.

Extremely poor water quality is created where streams flow through gob piles created by underground mining. Here the availability of limestone has no effect. The overburden taken out with the coal, enriched by ash and pyritic materials washed from the coal, is left on the surface. Such a pile near Harco, in Saline County, has destroyed the life supportability of the stream which flows through it. In this stream iron ranged from 0-1,900 mg/l, sulfate from 600-7,500 mg/l, and pH from 2.0 to 2.7 during the 208 water quality sampling program. A similar pile in Perry County has left the upper segments of Walker Creek surrounded by

dead trees, in addition to destroying the ability of the stream to support aquatic life. This situation is repeated in various other locations in the 208 area. Acid producing waters will seep from these piles for many decades to come. Each given problem area is local in immediate effect, but collectively they keep water quality below natural levels in the entire Big Muddy and Saline basins.

If coal mining is allowed to proceed in the drainage basins of high quality streams, such as Lusk Creek, the lack of thick limestones and possible highly pyritic overburden would cause considerable water quality degradation. In such an ecosystem as the Lusk Creek drainage basin, even short term water quality degradation could permanently alter aquatic populations.

CONTROL: MITIGATION AND PREVENTION

Erosion Control

Cropland erosion has been identified as the major contributor of sediment to 208 area general use and water supply waters. Because of this, any practices that are designed to hold soil in place and prevent or mitigate erosion will also result in higher quality waters in streams and impoundments. As a by-product, erosion prevention practices will also decrease pollution of surface water by pesticides, herbicides, heavy metals, and fertilizer nutrients.

The Erosion Subcommittee of the State Agricultural Task Force[16] listed erosion control practices and classified them according to suitability for use in various regions of Illinois. For the regions included in the ten county 208 area, the practices considered most suitable were conservation cropping, conservation tillage, crop residue use, terracing and waterways for cropland and planting, and management for pasture and haylands. These practices are described as being directly beneficial in erosion and sediment control.

These measures can be briefly described as follows:

Conservation Cropping

Conservation cropping system is simply tillage with good management

practices including proper maintenance of soil alkalinity and nutrient levels without exceeding useable levels of fertilizer, timing of tilling and seeding operations, and crop rotations including legumes and grasses.

Conservation Tillage

Conservation tillage is growing crops with a soil cover. The soil cover may be a crop residue left on the surface or with the natural growth cover left undisturbed through the high erosion risk months. Limited soil preparation is made for the seed row. Methods rated as suitable for the 208 area are zero-till, chisel planting, strip tillage, and till-plant.

Crop Residue Use

Crop residue use involves leaving a residue of the harvested crop during the non-growing season from harvest till planting.

Terraces and Waterways

Terraces are constructed across a slope. They consist of an embankment and channel, and afford movement of surface water at a non-erosive velocity to a prepared waterway. The waterway may be a lined or tiled construction or a grassed waterway. Other erosion control measures exist such as strip cropping and holding pond construction, but those given above are regarded as the best suited to erosion control in the 208 area. These controls are especially critical in water supply reservoir watersheds and on reclaimed mine lands.

Erosion Control Education Needs

Getting soil conservation practices in operation on all 208 area acreage would be a difficult task. The estimated cost of adequate total land treatment to control erosion in the 208 area is between 50 and 60 million dollars. Soil conservationists are prepared to help land owners plan and institute the methods most suitable to their land, but only a minority carry out and continue these practices even given financial incentives. Short term market prices appear to control what is planted

and where, more often than longer term soil conservation and water quality motives. Until the attitude that soil is there to be used for all it can do today gives way to attitudes of soil conservation, water quality degradation via siltation and chemical accumulation is likely to continue unchecked. Perhaps the first control measure should be to educate people concerning the long range over-all cost-effectiveness of starting and continuing control practices, taking water quality into account.

Management of the erosion control aspects of water quality restoration and maintenance should be the responsibility of the county Soil and Water Conservation Districts with assistance from Soil Conservation Service and help from Agricultural Extension Service in educational activities.

Agricultural Chemicals

Closely related to control of agricultural siltation sources is control of the accumulation of pesticides, herbicides, and heavy metals in surface waters. All erosion control methods are controls of these pollutants as well as controls of siltation. In addition, it is important that the amounts of these chemicals put into the environment be no greater than necessary to accomplish the intended task. Manufacturers instructions should be followed. Distribution equipment should work well and chemicals be handled so as to avoid spills. Research is needed to develop chemicals with a shorter half-life and insect control products that will attack pests in a way not harmful to predators or to aquatic or human life.

Nutrients also enter surface waters through erosion from agricultural lands. Amounts of nitrates and phosphates added to soil should not exceed what will be taken out with the harvested crop. Education is necessary regarding how to calculate fertilizer formulas and derive amounts more accurately. These programs should be the responsibility of the Soil and Water Conservation Districts.

Sewage Controls

Extension of sewers into unsewered areas; upgrading plants so that they do not operate over capacity; efficient operation of existing plants and restoration or replacement of private septic systems are measures that

would decrease the load of nutrients coming to streams and impoundments.

Municipalities should be responsible for upgrading of present facilities and for efficient operation of plants. The Regional Water Quality Council should arrange to monitor the success of these efforts and also provide for intergovernmental agreements that will allow sewer installation in unsewered areas and arrangements for treatment of sludge and septage pumped from private septic tanks.

Education of contractors, developers, and the general public by public health officials regarding maintenance of sewage disposal equipment plus a strict enforcement of laws in that regard would help eliminate the problem of faulty and inadequate septic systems. All counties need to be covered by a local health department and a coordinated effort made to get strong private sewage disposal ordinances in force in the ten-county area.

Before any of these things can truly be effective, the attitude held by many people that streams are provided for sewage disposal and trash dumping must change to one that views them as features of natural beauty, sources of clean, useable water, and as habitat for fish and other living things. The Regional Water Quality Council should arrange for and/or conduct public education campaigns to this end.

Mine Drainage Control

The threat of coal mining practices, past and present, looms large over 208 area flowing waters. Acid mine wastes have done extensive damage and will continue to do so until removed or somehow stabilized and neutralized. Strip mining practices have exposed barren areas to erosional forces adding to the siltation problems in streams and impoundments.

Old mine sites pose the greatest problem. Various ways have been suggested to deal with gob and other pyritic refuse. Many of them involve isolation of the material from oxygen and surface percolation. Any procedure that accomplished this isolation will prevent the chemical changes that yield heavy metal salts, iron hydroxide, and sulfuric acid - the major pollutants from coal mine wastes. Ponded acid waters

can be a pollution source, but if the pond is enclosed so that its level is maintained by evaporation, it will not pollute surface waters. Lime treatment of acid water raises pH value but often puts other parmeters in violation. It raises the life supportability of the water, but does not allow return of full, normal diversity of life forms.

Pyritic wastes can be spread on the surface covered by soil, fertilized and limed and revegetated with some degree of success. Erosion, however, reintroduces the acid-waste problem. Gob and slurry can also be reprocessed removing much of its volume as useable coal. But reprocessing does not render the material impotent - it may, in fact, make it more polluting than it was before by making it more permeable and more concentrated. Reprocessing should be followed by isolation of the material from oxygen and surface water or by extraction of the pyritic materials for commercial sulfuric acid production.

New strip-mine reclamation laws specify control measures that will minimize the impact of most present and all future surface mining by confining the heavy silt and acid runoff to relatively brief periods. This will allow stream recovery after mines close. Local situations should be monitored to see that reclamation plans are followed and that special practices, such as use of holding ponds and prompt revegetation of slopes, are applied where necessary.

Both old and new acid overburden and gob should be buried in storage areas chosen to minimize drainage to streams. Operating surface mine pits, old limestone quarries, and old underground mines have been suggested as mine dumping places. Placement in old underground mines may have the added effect of diminishing future subsidence problems.

County Boards and Soil and Water Conservation Districts should oversee contracts with mining concerns to arrange for dumping of appropriate amounts of old gob in new mine pits for coverage during reclamation in addition to their present responsibilities under the state Surface Mined Lands Conservation Act and under public law 95-87. Municipalities and Water Conservancy Districts should monitor mine reclamation activities in potential water supply watersheds.

Water Supply and Non-Degradation Waters

Municipalities, River Conservancy Districts, and Soil and Water Conservation Districts should jointly begin a program to improve the watersheds of water supply reservoirs under their jurisdiction. Through the Regional Water Quality Council they can address needs for implementation of control practices dealing with agricultural, construction, silvicultural, mineral extraction and other activities in the water supply watersheds. Municipalities should also be responsible to meet effluent standards at sewage treatment facilities and general use standards in streams accepting such effluents so that neither water supply reservoirs or waters used for recreation or stock watering will be in violation of general use standards.

The Regional Water Quality Council should assist the appropriate state agencies in the assignment of non-degradation status to 208 area streams. This designation procedure should draw on resources of Soil and Water Conservation Districts, River Conservancy Districts, and other entities familiar with the waters of the various counties. Once designation has been made, a management planning procedure should be carried out under the coordination of the Council designed to protect these waters from any degrading influences and if possible improve their water quality.

Education and Aesthetic Values

The most difficult, and perhaps most needed control measure, is the education (or re-education) of 208 area people to the aesthetic value of clean waters. People travel great distances to view scenic wonders involving surface waters. People also walk and ride to nearby locations associated with surface waters for solitude, recreation, and social activities. But when trash, stench, and acid water hues attack their senses the aesthetic value of a favorite location wanes rapidly. The U.S. Department of the Interior has quantified aesthetic value in a Hell's canyon study.[17] Application of this approach should be made in the 208 area and the public educated as to the aesthetic value of clean streams and clean swimmable impoundments. Attention paid to this aspect of the value of high quality waters will help turn public attention toward the need to apply time, money, and technological advances to the task of restoring and maintaining clean water. This could be an aspect of the public education campaign suggested above as a project of the Regional Water Quality Council.

CONTROL IMPLEMENTATION

Public water supply reservoirs and streams must be protected from further degradation and, where possible, improved in quality, as the first priority of program implementation. To accomplish this goal the major pollutant sources found in watersheds of surface waters acting as water supply sources must be removed or controlled through an active management program.

Best management practices for erosion control are needed on greater numbers of acres of agricultural lands in the supply watersheds to control sedimentation of reservoirs and to diminish the amount of suspended solids, pesticides, herbicides, and nutrients (and chemical reaction products of some of these) that enter surface waters in these watersheds. The percentage of managed acres in each watershed should increase according to a schedule of reachable goals toward an ultimate goal of 100 percent managed acreage in all water supply watersheds. This should include placement of critical acreage in forest and grasslands.

County Soil and Water Conservation Districts are designated as having management responsibility for agricultural sources of pollution. They will develop an operations and funding plan and educational program designed to achieve abatement of agricultural pollution within designated, critical erosion areas (areas with potential for 10 or more tons per acre per year soil loss) in water supply watersheds. The goal of this abatement program will be to achieve owner participation rates of 1 to 5 percent in 1979, 5 to 10 percent in 1980, 10 to 20 percent in 1981, 20 to 33 percent in 1982, and 33 to 50 percent in 1983. If these annual goals cannot be met through traditional voluntary programs state and federal regulatory mechanisms will be involved to achieve the goals through mandatory programs.

Funding of the voluntary program of soil erosion control in the ten-county 208 area will be by private funds amounting to $870,000 and federal matching funds from USDA/SCS/ASCS totaling $4,930,000 to be administered by the agricultural management agency. These cost amounts are expected to cover the goals through 1983. Federal funds are made available through the Clean Streams Act of 1977 (P. L. 95-217) on a cost-share basis at 50 percent match. However, provision is made for higher match percentages where important water quality benefits can be achieved. In view of this 80 percent matching is recommended for critical erosion areas of water supply watersheds and 90 percent where there will also be a financial burden on the landowner.

Costs through 1995 are expected to reach a total of 11.89 million dollars federal and 2.61 million dollars private as greater percentages of owners cooperate in soil erosion abatement implementation.

Progress reviews by the Regional Water Quality Council will occur annually at which time records of the Soil and Water Conservation Districts will be reviewed to determine if the goals stated above are being met. The voluntary system of management will be continued so long as year by goals are being met.

Water supply reservoirs or river side-channels used as water supply sources must be afforded protection from coal mine-waste drainage pollution from gob piles, slurry ponds, and processing areas of mines operated prior to the requirement of present reclamation practices. The Regional Water Quality Council should give first priority to reclamation efforts in the watershed of the Saline River upstream from Harrisburg and should consider designation of additional coal mining operations as incompatible with existing land use in the watersheds of water supply reservoirs.

Reclamation in the Saline Basin above Harrisburg should be by removal of gob and slurry in such a way that the greatest possible water quality improvement can be achieved for the moneys made available. The mine wastewater quality and cost optimization models developed for the ten-county 208 project should be used in updated form to determine the degree of reclamation required to meet water quality standards desireable for water supply source waters.

Least cost methods for removal of gob and slurry deposits in the Saline watershed above Harrisburg would include a combination of backfilling and blind flushing into abandoned underground mines and disposal into active strip mine operations.

Estimated cost for complete removal of gob and slurry from the Saline Middle Fork Watershed above Harrisburg is $8,145,000. Removal of selected deposits of refuse sufficient to meet basic water quality standards via least-cost methods[16] is estimated to be $3,721,300. Funds for this reclamation project would come from tax moneys raised under the Surface Mining Control and Reclamation Act of 1977 (P.L. 95-87) administered

by the Illinois Abandoned Mine Lands Council and the Federal Office of Surface Mining.

To prevent entry of effluent from private sewage disposal systems into water supply reservoirs there should be strict enforcement of sewage disposal ordinances in the respective supply watersheds by county health officials. In Hamilton and Jefferson Counties, the Regional Water Quality Council, in cooperation with Comprehensive Health Planning in Southern Illinois Inc. should support county government in the set-up of a viable combined health department or County Health Departments for each county. Support should be given Perry County to provide for an Environmental Health Division. These and the other Health Departments must be sufficiently staffed and have the backing of a strong private sewage disposal ordinance enforced by health personnel or county government.

Costs for creation of a bi-county (Hamilton-Jefferson) Health Department, addition of environmental health services in Perry County and strengthening staff available for water quality concerns in other departments will total approximately $96,500. About half of this amount would originate from State Health Department Funds and half from County funds. Costs will reach $510,000 during the period through 1983.

Streams and reservoirs having a general or recreational use and/or serving as a back-up water supply should be regularly monitored. This effort should concentrate on bacterial parameters, phosphorus, nitrogen, lead, arsenic, mercury, pesticides, and other possible parameters. Where appropriate mine-waste related parameters such as pH, total iron, and sulfates should be monitored. Swimming areas should be monitored on a regular basis in season and standards for beach closure established and enforced by Counties and/or the State Health Department.

The sediments of reservoirs and samples of fish taken from both general use and water supply reservoirs should be analyzed annually or bi-annually for content of mercury, arsenic, lead and pestice levels as a responsibility of the Illinois Department of Conservation, U.S. Forest Service, Water Conservancy District, municipality or other authority administering management of the respective reservoir. This type of monitoring effort is especially important for Cedar Lake in Jackson County. The cost of such a program for this reservoir is estimated to be $18,270 for the first year.

County Soil and Water Conservation Districts should work to bring increasingly greater percentages of general use reservoir watershed acreages under erosion control programs. Timing goals for this management activity should be the same as expressed above (paragraph three of this section). This effort would involve voluntary participation by landowners so long as a non-mandatory approach achieves the stated goals each year. Funds used in these erosion abatement projects would be private funds with 50 to 90 percent matching funds from USDA/SCS/ASCS and would be a part of the estimated $5,700,000 cost required to meet 1983 208 goals for erosion control in the ten-county 208 area.

Restrictions on housing development, industry, mining, and quarrying in both water supply and general use reservoir watersheds must be strictly enforced by the responsible governmental unit.

It is expected that the Regional Water Quality Council will designate certain waters which are not water supply waters as "non-degradable waters" within the first year of Water Quality Management Plan implementation. Streams listed in paragraph two on page 10 and such reservoirs as Devils Kitchen Lake, Lake Glendale, One Horse Gap Lake, and Pound's Hollow (see Table 1) standout as possible candidates for non-degradable designation. The designated waters must receive no additional non-point source pollutants from anywhere in the watershed. Such waters must not be allowed to accumulate any monitored parameter up to the level of state general-use standards. Instead any deterioration in established water quality for a given non-degradable stream or impoundment would become cause for investigation and action. The watershed areas of these waters would be largely forested, with sparce and/or restricted permanent human habitation and no coal mining, petroleum extraction or industrial activity.

All activities which tend to produce pollutants or increase erosion of soil must be greatly restricted in the watersheds of non-degradable waters. In consideration of these waters it should be the intention of the Regional Water Quality Council to preserve natural habitat. Aesthetic qualities associated with these waters should also be preserved. If possible water quality of non-degradable waters should be improved toward the achievement of re-establishing waters of nearly pristine quality in the designated ten-county 208 area.

Costs for meeting these requirements regarding non-degradable waters are included in administrative costs for the Regional Water Quality Council. Tree planting and other erosion control practices would be applied as part of the area erosion control program already described.

This program is described in greater detail in Appendix B-2, Pollution Sources: Agriculture, appended to the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois.[18]

The Regional Water Quality Council should annually review the progress of all programs related to the preservation of high quality waters for water supply and general use and to the preservation and improvement of those waters designated as non-degradable waters.

As a data base for this review, the designated waters must be monitored on a regular basis for many or all constituents considered in setting general stream standards in Illinois. An additional water quality monitoring cost of $19,000 per year is estimated to be necessary for meeting this need.

SUMMARY

208 project goals include a determination to maintain high water quality where it still exists and to restore water quality where it has been degraded. The goals of P.L. 92-500 call for the elimination of pollutant discharges by 1985 preceeded by an interim (1983) goal calling for water quality which provides for human recreational use and maintenance of communities of aquatic life which include fish and shellfish.

Classification of waters by use has enabled state authorities to set standards by which water quality can be chemically evaluated. These standards are tailored to water for human consumption and general use waters. Water of the desired categories of quality will support fish and other aquatic life, be swimmable by man, and be safe for our water supply needs.

There are sufficient good quality reservoirs in the 208 area to meet current water supply needs. Some streams in the 208 area in low population, forested areas are considered high quality streams. Impoundments in the area are threatened by siltation and the residues of pesticides, herbicides, heavy metals, and fertilizer nutrients that accompany it. Streams and impoundments are being degraded by sewage input and acid mine waste drainage.

Summary of Impacts

Row crop farming is responsible for most silt input to streams and impoundments. Of the 8,016,000 tons of soil loss to water erosion per year in the ten county 208 area, 6,089,000 are attributed to row crop land erosion. Mining, channelization, construction, and silviculture also cause entry of silt into streams. Some reservoirs are silting in at a rate that will make them useless in a relatively short time.

Pesticides, herbicides, and heavy metals in the sediment of streams and impoundments are concentrated in the animal food chain by fish food animals which feed on sediments and other bottom nutrients. Predator

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fish are at the other end of this food chain. While feeding on macro-invertebrates, they often accumulate high concentrations of poisonous materials. These same fish are prized by fishermen.

The nutrient ions, nitrate or phosphate, when in short supply act as a limiting factor which keeps aquatic living things in balance. Addition of phosphate or nitrate from agricultural fertilizers tends to over supply the limiting factor and cause eutrophication of impoundments and streams. This leads to blooms of algae and bacteria and causes die-offs of fish and many fish food organisms. Water quality is severely degraded by these events. If algacides are then used, they add new pollutants which accumulate in the sediments.

Sewage pollution of 208 area surface waters occurs because of unsewered areas of population concentration, poorly operated and/or overloaded treatment facilities, and a high percentage of failing and improperly maintained private sewage systems. Septic drainage to Lake of Egypt has caused serious organic pollution with less than half of the available private lots in the shoreline perimeter occupied by dwellings.

Coal mining is an important source of degradation to water quality in 208 area streams. It is basically a problem arising from acid and metal salt formation in water that has percolated through old pyritic refuse piles. At Harrisburg pollutants from pyritic wastes must be flushed out before the Saline River channel can be used to transport supplemental reservoir water to the water supply side channel. Some stream segments have entirely lost their ability to support life, but removal of pyritic wastes would lead to an eventual restoration of stream quality.

Outline Summary of Control Measures

Following is an outline summary of the principal control measures that are used or have been suggested to end or diminish input of pollutants to 208 area waters from the major area point and non-point sources.

Erosion from Row Crop Lands

Structural Controls:

1. Terracing and waterways construction on sloping land.

Process Controls:

1. Conservation cropping
2. Conservation tillage
3. Crop residue use
4. Planting and management of pasture and haylands.

Institutional Controls: County Soil and Water Conservation districts are responsible with S.C.S. and extension service assistance to foster the installation of soil conservation practices and to carry out the following:

1. Education projects to show the long-range cost effectiveness of soil conservation practices

2. Careful monitoring of management practices, especially those provided by Culver amendment funds

Agricultural Chemicals

Process Controls:

1. Accurate calculation of needs and mininum pesticide-herbicide-nitrate and/or phosphate application

2. Care in handling pesticides and herbicides to avoid spills

3. Proper upkeep and cleaning of equipment

Institutional Controls:

1. The Regional Water Quality Council should urge research and demonstration projects to develop and test quick-decay pesticides and insect control methods that will not harm predators

Sewage Disposal

Structural Controls:

1. Treatment facility construction in unsewered, populated areas when practical

2. Connection of unsewered communities to existing treatment facilities

3. Replace faulty and inadequate private septic systems

Process Controls:

1. Increase efficiency of existing treatment plants through training of personnel

Institutional Controls: The counties through establishment and strengthening of health departments and ordinances should provide for:

1. Education of private sewage systems owners regarding proper maintenance

2. Inspection of private systems and requirment of proper maintenance or replacement with improved or alternate systems

Acid-Waste Drainage from Coal Mines

Process Controls:

1. Remove mine refuse from contact with water and oxygen by burying, placing in old underground mines or by leveling, covering, and revegetation

2. Placement of pyritic mine refuse in non-draining old mine pits

Institutional Controls: County Boards and Soil and Water Districts should be responsible for:

1. Requiring careful monitoring of reclamation compliance by appropriate state agencies

2. Urging rigorous enforcement of laws concerned with mining and transporting of coal and reclamation of mined lands

3. Careful assessment of reclamation plans and knowledgeable reclamation recommendations

Channelization and Stream Bank Clearance

Structural Controls:

1. Construction of upstream and tributary - holding impoundments

2. Building of grade stabilization and sediment trap structures

Process Controls:

1. Following of old channel with cleaning and snagging process in place of clearing and channel straightening

2. Revegetation of cleared stream perimeter areas with natural trees shrubs, and herbaceous growth

Institutional Controls: Counties should be responsible for:

1. Land-use planning coupled with ordinances that prohibit clearing of stream perimeters and channel straightening

2. Obtaining a Regional Water Quality Council voice in the 404 permitting process

CONCLUSIONS

If the goals of public law 92-500 are to be met in the 208 area, such relatively clean waters as Lusk Creek and Big Grand Pierre Creek, and impoundments such as Lake Kinkaid, Cedar Lake, Rend Lake, Lake Glendale, and One Horse Gap Lake must be insulated from all known polluting factors. Currently degraded waters must begin to receive cleaner inputs of effluent and runoff. In accomplishment of these needs the best current knowledge and technical capabilities must be applied. But none of this can be done properly and to a full enough extent without some turn arounds in the attitudes of people. That is why education is treated as a control measure in this paper.

The stream-as-sewer mentality and the economic growth-environmental destruction trade-off myth have allowed 208 area residents to stand by while streams collected trash, nutrient overloads, and acid which badly damage the aquatic ecosystem. The technology exists to reclaim good water quality in these same surface waters that have been degraded and to protect area water supplies and scenic areas from degradation. However, there must be a means and a willingness to change attitudes before the technology will be called into action and applied wisely to the tasks.

There does not have to be a trade of environmental destruction for economic growth where water quality is concerned in the 208 area. If aesthetic values are given serious consideration and the value of planning for the future use of water resources given consideration, high quality water restoration and preservation will be seen as the only wise choice for sustaining economic growth as well as for environmental preservation. The implementation phase of the 208 water quality program should be based upon these philosophies if it is to succeed.

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FOOTNOTES

[1]The 208 Macroinvertebrate Study Report: The Effects of Acid Mine Drainage on Mean Species Diversity in Six Southern Illinois Streams. A report appended to the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois (Appendix C-4). GERP&DC in cooperation with SIRP&DC, 1978.

[2]Roseboom, Evans, and Hill. Water Quality in Cedar Lake and the Relevance of its Watershed. A report appended to the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois (Appendix B-4). GERP&DC in cooperation with SIRP&DC, 1978.

[3]Hite, Robert L. and King, Marvin. Biological Investigation of the Crab Orchard Creek Basin Summer 1975. Illinois Environmental Protection Agency, Division of Water Pollution Control, 1977.

[4]Ibid.

[5]Roseboom, Evans, and Hill. op. cit.

[6]Illinois State Water Survey, Water Quality Section. Water Quality Assessment of Rend Lake and Its Tributaries. A report appended to the Areawide Waste Treatment Management Plan for Southern Illinois (Appendix B-4). GERP&DC in cooperation with SIRP&DC, 1978.

[7]Ibid.

[8]Ibid.

[9]Dreher, Muchmore, and Stover. Major, Minor, and Trace Elements of Bottom Sediments in Lake DuQuoin, Johnston City Lake, and Little Grassy Lake in Southern Illinois. Environmental Geology Notes #82, Illinois State Geological Survey, Urbana, 1977.

[10]Poston, Richard W. A Report on Environmental Protection at the Lake of Egypt. Southern Illinois Power Cooperative, 1970.

[11]From conversations with Richard W. Poston.

[12]Hite, Robert L. and King, Marvin. op. cit.

[13]Ibid.

[14]From analysis of Greater Egypt Regional Planning and Development Commission 6-month water quality monitoring program results.

[15]Geology of the Coal-Mining Portion of the Southern Illinois 208 Area and Its Applications to Water Quality Problems. A report appended to the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois (Appendix C-4). GERP&DC in cooperation with SIRP&DC, 1978.

[16]The Erosion Subcommittee of the Illinois Task Force on Agricultural Nonpoint Sources of Pollution. Best Management Practices, unpublished, 1977.

[17]Geological Survey Circular 620, Quantitative Comparison of Some Aesthetic Factors Among Rivers. U.S. Department of the Interior, Third Printing, 1973. (free) Reston, Virginia, 22092

[18]Pollution Sources: Agriculture. A report appended to the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois (Appendix B-2). GERP&DC in cooperation with SIRP&DC, 1978.